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GLIDERS

By CARL O. HORST, '31

HISTORY

To those of us who keep in close contact with the subject of aviation, it appears trite to say anything about the beginning of air navigation. We have all read the story of how men gazed wistfully at the lazily floating vulture in the far-away blue and wished they could sail up there too. What the human mind wants it gets. The Greeks in their mythology told of Icarus and Daedalus, but it was not until Lillienthal's time that sailing flight was realized. Chanute carried on experiments in northern Indiana and finally arrived at a glider very similar to the one the Wrights used in their first trials, except that he did not "warp" the wings as the Wrights did. Since Chanute's experiments were kept comparatively secret, Lillienthal gets credit for the beginning of the modern glider.

After Lillienthal was killed in a poor landing, several devotees "kept at it" more or less separately. In those days all gliders were of the suspension type; that is, the flyer hung in them or lay on the wing and shifted his body for balance or control. There were no other controls except the stabilizer, which, of course, as the name indicates, is a flat surface for stabilizing, holding steady the "ship." This type was not entirely satisfactory; so, when the airplane came into use in some numbers, certain of these early sail-fliers (a term applied to glider pilots) used airplanes as gliders merely by shutting off the motor. These men are the real progenitors of the modern sailplane or performance glider. The glider is no more today than an efficient, highly specialized, clearly designed airplane. The early airplanes were clumsy gliders with power attached.

Gliding, up until the World War, more or less languished; but the Versailles Treaty did more for the sport than any other single historical document or occurrence. Germany, no longer allowed to build powered "ships" except for commercial service and then only in limited numbers, turned to gliding. In the northern part of their country the Germans have almost ideal territory for performance gliders, and in the south are the mountains where true gliders can be used easily, as well as more advanced types. In this part of their country meets were held every year, and records were made each time.

Many clubs were formed and they all competed. Numbers of gliders almost doubled each time a meet was held. The first distance was about a quarter of a mile; the last was thirty-nine miles. The first duration record was but a few minutes—three, to be exact; the last was nineteen hours and twenty minutes. The first altitude record was a negative quantity; that is, the glider fell a way then rose a little and settled down to land; the last altitude record was something over six thousand feet. These figures are reckoned from the starting point.

On the first of January, 1928, Germany was again permitted to build power "ships," and so she started out to give the glider to the other nations. In the spring some Americans financed the introduction of German gliders and gliding practice in America. A glider which was almost an exact reproduction of the record-holding Darmstadt was brought to this country, set up, and flown at Cape Cod. This event started the discussion in this country, and several clubs have been formed; but so far not much advance has been made in gliding.

THEORY

A great deal can be learned with regard to the construction of gliders by considering the two types of flight used by birds. The small birds have to flap their wings very rapidly in order to remain aloft—except true finches, which fly by sheer speed. These birds, among which is the canary, fly by dropping with wings closed until they have a great speed and "zooming" with outstretched pinions. (Zooming is the term applied to rising at the expense of speed by the use of inertia.) True gliders can use this "bounding" flight, but it is not advisable in a sailplane.

The larger birds, such as albatrosses, condors, vul-

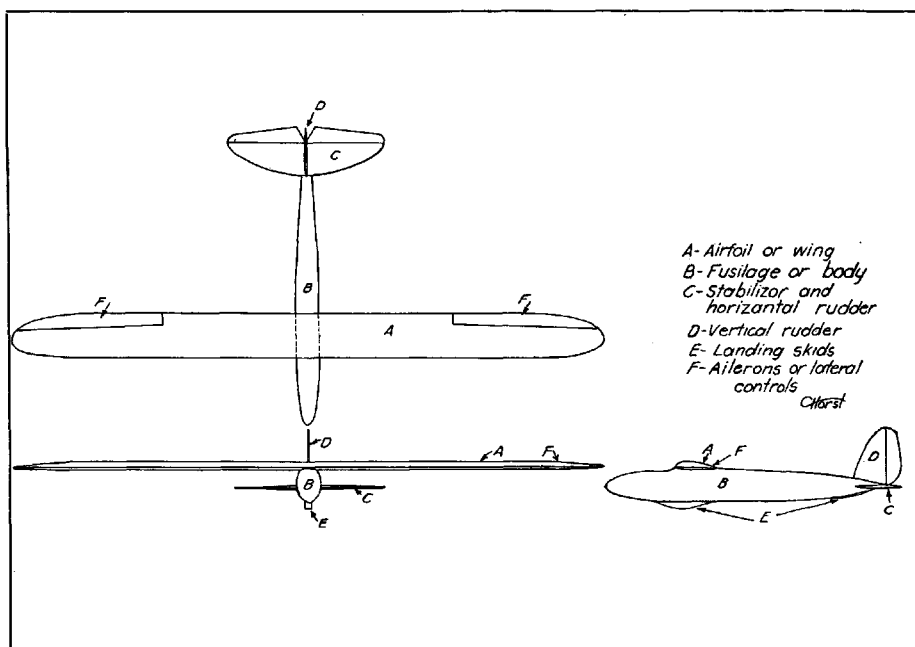
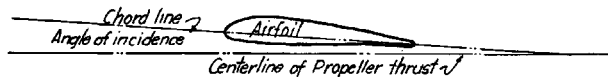


Diagram of Glider

tures, and even gulls fly by delicate adjustments of body and wings with only slow, easy flapping occurring after long intervals. Such is the flight of the sailplane or performance glider.



These large birds utilize, of course, rising currents and direct winds in their flying. They can fly like a finch or combine the two flights. It appears that they usually ride the hillside or convection currents, but occasionally one sees them sailing in the air as easily as a yacht in the breeze when there is no wind at all. They may be seen in the winter as well as in the summer—and convection currents in the winter are practically nil. How can we account for this?

Witnessing the "take-off" of a vulture, one sees him run a few steps with wings spread and turn himself upward. When he is high enough from the ground he commences flapping very rapidly and powerfully. (If he flapped when he started, his wings would strike the ground; so he "taxi" like an airplane.) It is obvious that he is gaining speed and altitude by his exertions. It is supposed that he does this in order to start zooming like a goldfinch, except that he does not completely close his wings but merely draws them part way in. We must consider his efficiency in zooming and concede that he does not rise higher except at the expense of speed. That is why he starts fast. When his speed is decreased so that there is danger of "stalling" (stopping dead in a climbing position), he flaps a few times.

An airfoil (wing) is lifted by the reactions of air upon it. These depend principally on the density of air, the relative speed and direction of motion of air and airfoil, the angle of incidence or attack, the acceleration of gravity, and the pressure of the air at the airfoil's level. The reactions set up are head resistance (impact), skin frictions, drift (sliding along with the wind), kite action (effect of wind on bottom), upward pressure on the airfoil's bottom due to the partial vacuum above it, tendency to fall, and extent of rarefied region above the airfoil.

A decrease in area decreases the lift unless the airfoil moves faster. Likewise an increase in area increases the lift unless the speed is reduced. Up to the "burble point" (about 20 degrees) angles of incidence increase lift. The burble point is that point in incidence where air no longer flows above the airfoil in a constant unbroken stream.

A vulture flies by gaining speed (flapping), increasing area and incidence, and rising. Then he decreases speed until he reaches the top of a zoom, draws in his wings, and again speeds and zooms. If his speed is increased enough each time, he can rise a little higher until he nearly stalls and then can begin all over again with a few flaps. Convection currents are rising anyway, and if he finds one of them he can ride it without "zooming," or he can make his way upward in the face of a powerful wind apparently without effort.

A sailplane cannot move its wings with relation to its center of gravity and so must rely on air currents alone. If area, incidence, and center of gravity could be varied, a sailflier (glider

pilot) could "bound" his "ship" and so fly independently of winds or convection currents just as a vulture does. But, as before stated, the sailplane wing is fixed in area and structure and position, so a sailflier must fly only winds or currents.

This limit, however, is only occasionally felt because usually there is a wind blowing or there are convection currents over different types of landscape. A sailflier knows what kinds of currents are to be found over each type of field, wood, or town, as well as over hills, dunes, or mountains and tries to pilot his "ship" so that he may be in a rising current the greater part of the time.

These rising currents occur on the windward side of hills, mountains, dunes, woods, towns, and cities especially. Obviously, these particular currents are caused by the winds striking an obstruction. They are felt at heights considerably greater than one would at first suppose. Then there are other rising convection currents which occur over reflecting (heat-reflecting not light-reflecting) surfaces such as plowed fields, surfaced highways, and some cities, as well as near large bodies of water. In short, a little knowledge combined with experience will tell where there is a rising or a falling current.

But it is not so easy to know where you will fly into a rising current if you are quite high in the air, since the currents may not rise vertically. The science, technique, or "knack" of flying a sailplane consists of boldly starting into the wind and then by "feeling," knowing into what attitude to put one's "ship" so as best to utilize the current at hand, as well as knowing where a current is apt to be found. A good idea of the probable strength of a current likely to be encountered is a great help in determining to what extent one should control his "ship" when he "feels" the current. When an aviator uses the word "feel," he means the slightest change in relative motion of "ship" and wind as indicated by the attempted motion of the "stick" or control lever.

To sum up, then, the theory of sail-flying, we could say it is the art of utilizing each slightest variation in wind intensity and direction so as to impart to one's "ship" the maximum rising and advancing tendencies obtainable from the wind available at each instant.

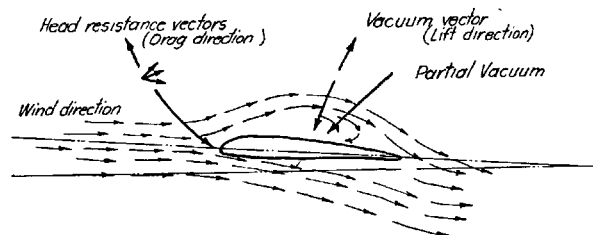
CONSTRUCTION (GENERAL)

There are three types of gliders which for convenience we will call number one, number two, and number three (1, 2, 3).

Type 1 is for training purposes only, and performance is really out of the question, although there have been some that had good qualities as performance "ships." These gliders along with Type 2 may be designated as true gliders.

In construction Type 1 is the simpler. It is built of a wing only, with a seat suspended in a frame below it. The machine may or may not have

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GLIDERS

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a vertical rudder, but a horizontal rudder is an essential.

This type, as before stated, usually cannot rise above its starting point, but can only glide down a hill. It is used almost entirely for student training.

Type 2 is a little more advanced. It can, as a rule, rise above its starting point, but only for a short distance. In addition to its wing, it has a fuselage suspended below and an enclosed seat. It usually has a vertical rudder as well as a horizontal rudder. Both 1 and 2 have wings in a chord-span (width-length) ratio of about one to ten or one to twelve. Type 2 is used for advanced training and some performance work.

Type 3 is a clean, efficient "ship" and is really not a glider but a sailplane. It is composed of a long, slender, efficient wing. All construction is cantilever; hence no braces extend into the wind. In this type everything else is sacrificed to performance. It has a chord-span ratio of from one to fifteen to one to twenty-five. It is used only by those who have thoroughly mastered the other two types. It was a Type 3 ship that was brought to this country last year.

In Types 2 and 3 all braces are enclosed so as to present a minimum frontal resistance. In addition, the fuselage and wing are so designed as to leave very small skin friction (friction of air on sides, top, and bottom during passage). The cleanest designs are always the most apt to make records. Type 1 sometimes has no vertical rudder, but in all three types the empennage (entire tail assembly) is made ample in size, light in weight, and strong. Of course, in the two higher types the rudders have a slightly different plan form (length and width measure plan) in order to secure better aerodynamic characteristics, but their internal construction is the same.

CONSTRUCTION BY PARTS

The airfoils are composed of two parts, the ailerons and the airfoils proper, and are built up of spars and ribs. The spars are length members, and aileron mounting pieces and ribs are the chord members or width members.

The spars, except the aileron spars, are as long as the wings and are the mounting members for the ribs. They are long cantilever beams with fastenings at the center for mounting the fuselage and are usually two in number.

The aileron spars are short and are found near the airfoil tip where the ailerons must be mounted

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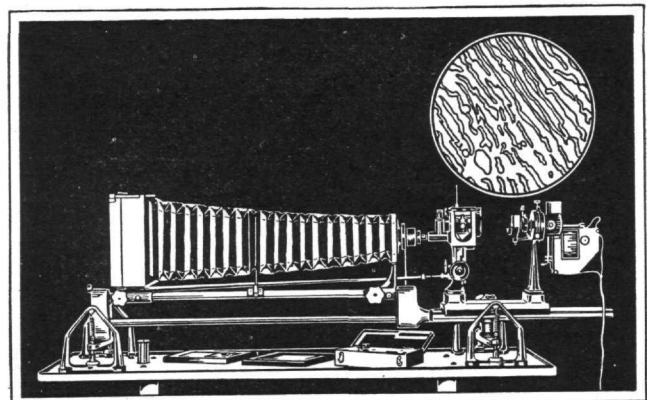
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for maximum controlling effect. The ailerons are hinged to them.

The ribs impart to the wing its curvature, which for a glider must be of high value so that lift and strength will be great. High value refers to the thickness with relation to the width of the wing. They are of two kinds, true and false. The false ribs are merely light trusses cap stripped (cap strips are top and bottom strips). The true ribs have either a strong truss or a solid thin board between the cap strips. The two kinds are alternately spaced along the spars.

The tail surfaces are built just as the airfoils except there is but one spar. The ailerons and elevators (control parts of the empennage) are built of the trailing edges of ribs hinged to the spar through hinges on a spar running along their forward edges. The fin and vertical rudder are constructed in the same manner. (Fin is stationary part.)

For lateral control the ailerons are only alternately movable so that they will impart a rocking motion (sidewise) to the ship or resist such a motion. For horizontal (altitude) control the elevators' halves are not alternately movable. For turning, the vertical rudder is used.

The fuselage is composed of four length members (longerons) to which the airfoil and landing gear as well as the empennage are fastened. These length members are trussed by uprights at points called stations along their length. A seat is near the front end of the fuselage. The entire "ship" is usually covered with flight fabric or airplane cloth.

The writer wishes to acknowledge his indebtedness to Major Victor Page, and his book *Modern Aircraft*; to *Aviation* magazine; to *Aero Digest*; to *Air Travel News*, and to *Popular Aviation*. *Popular Aviation* has given the most comprehensive information on the subject because it is popular, while *Aviation* and *Aero Digest* are technical; *Air Travel News* is a business man's magazine.
